Review of 'Grain size modulates volcani ash retention on crop foliage and potential yield loss' by Ligot et al.

I read with great interest the manuscript submitted by Ligot et al. reporting on the results of lab experiments in which tomato and chili pepper plants are exposed to ash fallout of various grainsize, and the effect on the coverage of leaves is quantified. The manuscript proposes a relationship linking ash grain size and foliage cover, and further model the impact on potential yield loss. I am not a bio-engineer so I am not able to comment on the relevance and potential shortcoming of this later modelization, but I recognize the scientific interest in translating a hazard into potential consequences.

The manuscript is very well written and structured, it is rather concise and illustrated by well-designed figures. Reference is being made to many supplementary material: whereas for most it is justified to propose this material as supplement, some figure might better fit into the main manuscript.

The proposed methodology and the obtained results are quite original, at least for the volcanology discipline, and could have relevance for risk assessment; I therefore advise that this manuscript should be accepted for publication in NHESS after minor revisions are implemented in the manuscript, based on the comments made hereunder.

LITERATURE

In the introduction, information from post-eruption field assessment are shortly reviewed, as well as some papers focusing on the effect of dust/ash on plant more specifically (line 74-90). However, in the discussion, the authors point out to the existence of previous field and experimental work more specifically related to their research (by Miller et al., Johnson et Lovaas, Hirano et al.). It is needed to shortly mention these previous research in the introduction to justify that 'ash grain size, leaf pubescence and ambient humidity have been suspected to affect ash retention on foliage' (lines 91-92);

EXPERMENTAL PROCEDURE

The methodology section describe in quite some details the novel experimental protocol implemented in this research. However, some elements could be further clarified. Additionally, a figure (or photo) representing the entire setup, including the device to spread the ash and the imaging system, would help the reader to understand the protocol.

- Line 111: specify the typical height of plants and typical surface areas of leaves at the time of experiments;
- Line 119: crushing phonolite rocks: did you check the morphology of the produced particles using SEM after crushing and compared to actual ash? Although I understand that crushing might be the best way to generate large ash fraction, the morphology of particles might influence their interaction with leaves.
- Ash loading of 570 g m^{-2} (line 129): why did you select such loading that could be considered very low. Could it be expected that at larger loading, larger surface of leaves be covered until the grainsize does not matter anymore (see main comment below). Further discussion on the potential impact of ash loading on the observed relationship would be useful.
- Line 133: "through a 2 cm-mesh sieve" – is this correct? 2 cm seems extremely coarse relative to the ash used and would not help to distribute the ash evenly across the device.
- Lines 135 and following: the protocols should be more specific for what concern the timing and location of different actions. What was the duration between the spraying of water on

the leaves (for wet condition), the spreading of the ash and the acquisition of the pictures? Did these action follow each other within minutes or were there hours/days in between? Was spreading of ash conducted at the same location of the acquisition of the picture or was the plant displaced?

- Line 145: precise here that image is acquire before and after ash fallout (mentioned later on, but needed here for better understanding).
- Ash retention: was there any way to quantify the proportion of ash that was retained on the leave versus the ash that reached the ground? Were the plant weighted before and after the ash fallout?
- Lines 160-165: issue of leave bending. Authors report that some of their measurement returned higher 'green leaf surface' after ash exposure than before, claiming that this is due t movement of leaves and camera during image acquisition. As these issues probably affected all their measurement, the accuracy of the documented covered leave surface could be derived by considering the noise observed for experiments were the retention is close to zero. Additionally the issue of leave bending should receive further attention in the description of results: did significant bending or change in orientation of leaves were observed? For which grain size? Beyond the impact on the imaging procedure, the bending would also directly influence the potential of retention of ash? This is mentioned on line 266 ('which pulls a leaf downward') but no comment is made on whether this process was observed during experiments;

OTHER FACTORS

- **Ash loading**: authors decide to work with a single ash loading for all experiments. They properly argue that they select an ash loading that is below the threshold for physical damage for the plant (is such threshold well defined? Is it plant specific?). Assumption is made that the relationship between grainsize and foliage cover found for this ash loading would be valid also for other loading (or at least the type of relationship – lines 231-32). Would the retention of ash not relatively increase with increasing ash loading? Until a point were all the leave surface are covered irrespective of grainsize?
  Could it be assumed that once a first layer of ash is retained on the vegetation, the effect of grainsize on accumulation would not be valid, the ash particles creating their own roughness at the surface? Further discussion on the ash loading for which the observed role of grainsize might be valid should be further discussed. Similarly the reader should be reminded that the yield loss mentioned are only valid for the ash loading used in the experiment and that ash loading will most probably be a significant parameter in controlling foliage cover.
- **Residence time of ash**: very limited attention is giving to the time component; Authors consider the timing of the ash fallout relative to the growth of the plant, but not the duration of the ash retention on the leave (assuming early senescence of ash covered leaves). As the duration of residence not been considered in previous study? For how long does the ash need to cover the leave to cause decay? In intro (line 87-88) and discussion (line 449-450) this issue of duration should be shortly mentioned (in relation to wind/rain 'erosion')
- **Physical integrity**: authors systematically mention that they consider impact of ash on foliage for loading below the loading required to affect 'plant integrity' (line 99). However this threshold is not clearly defined (line 304: 'cm-thick'). I guess this threshold will be specific for each plant and development stage of a plant. This could be further clarified in discussion,

IMPLICATIONS

In both the introduction (lines74-75) and conclusion (line 491), authors claim that understanding and quantifying the retention of ash on crop foliage represent an essential step in mitigating the impact of eruption on agriculture. I agree that the presented results will contribute to better assess quantitatively the potential impact of ash fallout on crops (reduced yield), however it is unclear to me what the author consider as potential mitigation measures that could be derived from these results. The mitigation actions should be specified or the focus should be on the impact assessment.

SMALL EDITS

- Abstract is well written but could be shortened both in the problem statement and the results implication
- Line 41: 'farming activities ARE exposed'
- Line 48: 'economic loss' – in country with subsistence farming the issue of food shortage would also have to be considered.
- Line 76-79: which ash thickness/loading is considered to calculate these areas of crop affected?
- Figure 1: specify the number of experiments represented by each boxplot (is it 15?). Explanation of how to read the box plot (median, 25-75th quantile) should be added to caption.
- Figure 3: add scale bar or specify the area imaged in the caption.
- Line 285: figure 1 highlight that surface wetness has more influence on retention for chili pepper than tomato plan. This observation should be discussed here: I guess that leave pubescence and wetness act in a similarly way, so that wetness induces lower additional retention with tomato plants
- Line 320: explain what is the 'harvest index'
- Line 335-340: explain here how the impact of ash on the plant growth is simulated through leave senescence followed by new leave growth.
- Figure 6: provide also the results for chili pepper in the main text, these are important results.